Mineralogy and S Isotope Signatures of Sulfides from Boriskino and Tagish Lake Carbonaceous Chondrites

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Boriskino, a CM chondrite, contains two distinct sulfide mineral assemblages: 1) a primary assemblage consisting of pyrrhotite, Ni-bearing monosulfide , pentlandite, and P-bearing Fe-Ni sulfide; and 2) a secondary assemblage consisting of pyrrhotite veins, magnetite, and Fe-Ni metal with extremely variable Ni content .. The secondary assemblage is associated with aqueous alteration and carbonate precipitation. Pyrrhotite is the only sulfide in the sample we investigated from Tagish Lake. It occurs either as rims on magnetite framboids or as more disseminated grains.

S isotopes were measured by SIMS using a Cs^+ primary beam and extreme energy filtering to eliminate interferences. Primary pyrrhotite in Boriskino is enriched in S^{34} (δS^{34} +1.01 to +5.89 ‰). A single grain of pyrrhotite that exsolved pentlandite had a negative δS^{34} (-1.28 ‰). Secondary pyrrhotite veins were mostly depleted in S^{34} (δS^{34} –6.35 to +1.96 ‰). The δS^{34} of pyrrhotite grains in Tagish Lake ranged between +0.99 and +1.97 ‰, whereas the pyrrhotite rims had low negative values (δS^{34} –1.31 to –0.05 ‰).

Boriskino primary sulfides are isotopically heavier than the sulfides from Murchison CM2 meteorite and the CM clasts in Kaidon meteorite. The S isotope data are consistent with a nebular origin for the primary sulfides. The low δS^{34} of secondary pyrrhotites coexisting with magnetite may be attributed to their precipitation under more oxidizing conditions from aqueous fluids that partially dissolved some of the primary sulfides. Alternatively, it may be attributed to kinetic isotope effects due to lack of equilibration between the sulfur-bearing species in the fluid.